

Photovoltaic Studies on SILAR Deposition of Copper Sulphide (CuS) Thin Films

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ABSTRACT

Copper sulphide thin films were deposited by simple Successive Ionic Layer Adsorption and Reaction (SILAR) method on glass substrate from aqueous solution consists of CuCl_2 , Na_2S as anionic and cationic precursors. The semiconductor properties of this material are suitable for application in heterojunction solar cells. The structural and optical properties were studied by means of X-ray diffraction (XRD), scanning electron microscopy (SEM) and UV-VIS spectrophotometer. The results showed the SILAR method allows the formation of n-type CuS thin films.

Keywords: Copper Sulphide, Na_2S , XRD, SEM, SILAR.

1. INTRODUCTION

A unique property of copper sulphide is a promising material with potential applications in photovoltaic fields. Copper Sulphide is a representative of II-VI chalcogenide semiconductor with unique characteristics of photo electricity conversion. The production of CuS thin films has been investigated for many years. The semiconductor properties of this

material are suitable for application in heterojunction solar cells¹⁻⁴. CuS can be synthesized by numerous techniques such as thermal evaporation, sputtering, chemical vapour deposition, sol-gel dip coating and spray pyrolysis methods⁵⁻¹⁰. Among the various deposition techniques, the SILAR is the well suited for the preparation of copper sulphide thin films because of its simple and inexpensive experimental arrangement. In this work we describe the production and

characterization of CuS thin films grown on glass substrates. The growth technique used was the SILAR deposition and the films were characterized by scanning electron micrographs, x-ray diffraction and optical transmission in the visible and near infrared.

2. EXPERIMENTAL

CuS thin films on cleaned glass substrates. CuS thin films were deposited using 0.1M CuCl_2 , and 0.05M Na_2S for cationic and anionic solutions for these films. The cationic and anionic precursor solutions characteristics: adsorption, reaction and rinsing times were detailed in literature for these thin films¹¹⁻¹³. One SILAR cycle contained four steps: (a) the substrate was immersed into first reaction containing the aqueous cation precursor, (b) rinsed with water, (c) immersed into the anion solution, and (d) rinsed with water. The experiment was carried out at 120 SILAR cycles so that expected thickness was obtained. The substrates were first cleaned using distilled water and later dried in air.

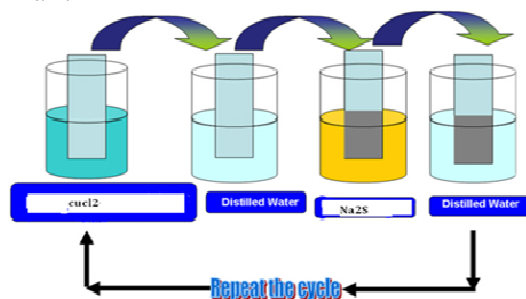


Fig. 1. Schematic representation of successive ionic layer adsorption and reaction (SILAR) method

3. RESULTS AND DISCUSSION

3.1 X-Ray Diffraction studies

The X-ray diffraction patterns (XRD) are analyzed to obtain the structural information of thin film. The structural analysis of CuS thin film was carried out by using X-ray diffractometer. The X-ray diffraction patterns of the as-coated substrates are shown in Fig. 1. The CuS films were found to have the hexagonal crystal structure with strongly preferred orientation along the (100) plane parallel to the as-revealed from the XRD studies. The planes (100), (104) and (110) indicate the hexagonal crystal structure for CuS thin film.

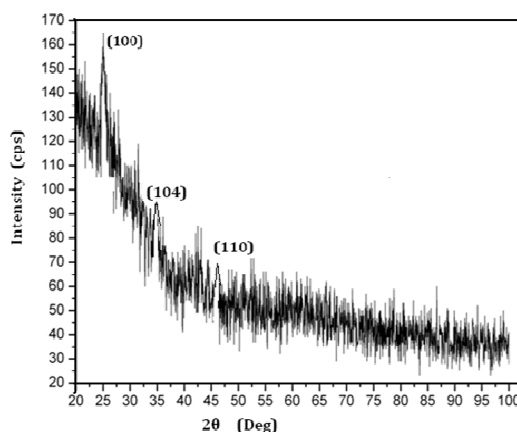


Fig.2 XRD pattern spectrum of the CuS film

3.2 Morphological analysis

Figure.2. Shows SEM images of as-grown CuS thin films. It is seen that well-crystallized grains in the image belong to these films. As can be seen in Fig. 2(a-c) the CuS film was dense, uniform and homogeneous without visible pores and covered well with substrate. The size of crystallites are from 100nm to 190nm

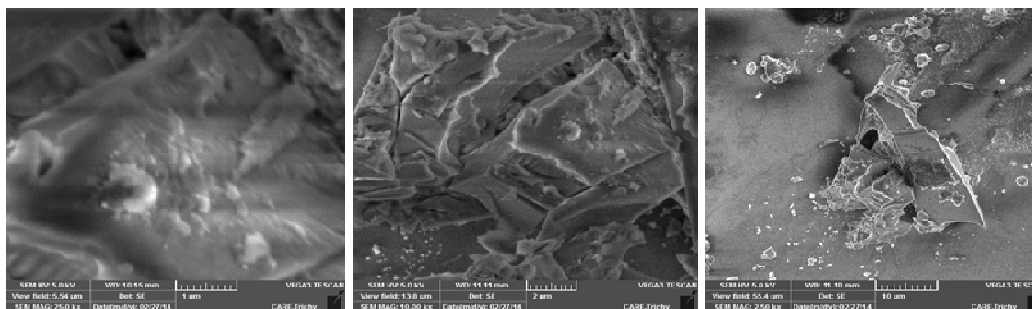


Figure 3: The SEM images of the CuS thin film (a) 1 μm (b) 2 μm (c) 10 μm

3.3 Optical studies

The absorption edge of the annealed CuS film appeared to shift towards the longer wavelength side. These data were further analyzed from the following classical relation for near edge optical absorption in semiconductors,

$$\alpha h\nu = A(h\nu - E_g)^n \quad (3)$$

Where A is a constant and E_g is the optical band gap. Thus, a plot of $(\alpha h\nu)^2$ versus $h\nu$ is a curve line whose intercept on the energy axis gives the energy gap. The band gap energy of the film have been determined by the extrapolation of the linear regions on the energy axis, $h\nu$. The band gap energy of the CuS thin film with 120 SILAR cycle is 2.16eV. The results of energy band gap of CuS thin film as indicate suitable candidate for p-type layer of heterojunction solar cells.

4. CONCLUSIONS

The SILAR method was used to deposit CuS thin film on glass substrate. Structural Properties of these thin films were investigated by XRD, SEM and UV-VIS methods. CuS thin films were

investigated by X-ray diffractometer and their main diffraction peaks are found to be in agreement the other studies. The morphology of the CuS thin films were changed with variation of the route and coating technique. A morphological study reveals uniform and compact CuS films nature with hexagonal structure and the crystallinity improvement as evidenced from SEM study. The results of energy band gap 2.16eV of CuS thin film as indicate suitable candidate for p-type layer of heterojunction solar cells.

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